

A Definition of Molecular Imaging

A report from the
Definitions Task Force
p. 3

MI in the literature

MI Gateway presents a selection
of top molecular imaging papers
p. 4

Images of Interest

The images selected for this edition
of the MICoE newsletter highlight
the power of dual modality imaging.
p. 5

MI in the News

A sampling of research and
news of interest to the community
of molecular imaging scientists
and physicians.
p. 6

Vol. 1 | Issue 1 | 2007-1

mi gateway

the newsletter of the snm molecular imaging center of excellence

message
from the president

Just What Is Molecular Imaging?

By Sanjiv Sam Gambhir MD, PhD

NEW discipline: Molecular imaging is a new biomedical research discipline enabling the visualization, characterization, and quantification of biologic processes taking place at the cellular and subcellular levels within intact living subjects including patients.

NEW context: The images produced with molecular imaging reflect cellular and molecular pathways and mechanisms of disease present in the context of the living subject. Biologic processes can be studied in their own physiologically authentic environment instead of by in vitro or ex vivo biopsy/cell culture laboratory techniques.

NEW paradigm: The term *molecular imaging* itself encompasses a new imaging paradigm that includes multiple image-capture techniques, cell/molecular biology, chemistry, pharmacology, medical physics, biomathematics, and bioinformatics.

NEW purpose: Molecular imaging's key utilization is in the interrogation of biologic processes in the cells of a living subject in order to report on and reveal their molecular abnormalities that form the basis of disease. This is in stark contrast to the classical form of diagnostic imaging where documented findings show the end effects of these molecular alterations typically via macroscopic and well-established gross pathology.

Molecular Imaging and Nuclear Medicine

Molecular imaging includes the field of nuclear medicine along with various other fields that together offer an array of different strategies to produce imaging signals. Whereas nuclear medicine uses radiolabeled molecules (tracers) that produce signals by means of radioactive decay only, molecular imaging uses these as well as other molecules to image via means of sound (ultrasound), magnetism (MRI or magnetic resonance imaging), or light (optical techniques of bioluminescence and fluorescence) as well as other emerging techniques.

Continued on page 7. See MI.

MICoE Leads Implementation of SNM's New Mission

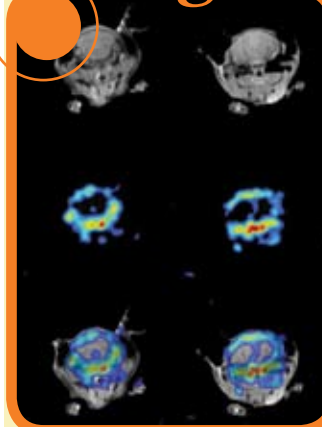


Martin Pomper, MD, PhD

On behalf of the leadership of the Molecular Imaging Center of Excellence (MICoE), I would like to update you on current SNM and MICoE activities. We are leading implementation of SNM's new mission to improve health care by advancing molecular imaging and therapy. Our ambitious strategic plan—supported by a five-year, \$5 million Bench-to-Bedside Campaign—encompasses communications, education, advocacy, and research activities focused on individualized patient care through molecular imaging and therapy.

Continued on page 2. See President.

images OF INTEREST



We have selected the latest in the lineage of fused imaging modalities for the inaugural *MI Gateway* featured image. The MRI/PET scan from Simon Cherry, PhD, Department of Biomedical Engineering University of California, Davis, highlights the exquisite coupling of two modalities that years ago would have been thought to be impossible because of the difficulty of developing components that would withstand the magnetic field of an MR scanner. Simultaneously

acquired PET and MR images of ^{18}F fluoride in a mouse: First row, MR images; second row, PET images; third row, fused images. See page 5 for more selected images.

—Henry VanBrocklin, PhD

Reprinted with permission from
The Journal of Nuclear Medicine (2006;47:1975).

President. *Continued from page 1.*

The process of diagnosing and treating disease is shifting from a single specialist interacting with a patient to a multidisciplinary approach that retains a focus on the patient. The focus of nuclear medicine is facing a parallel evolutionary shift—from function at the organ/tissue level to imaging changes at cellular and molecular levels. In addition, nuclear medicine is being coupled with other imaging modalities to improve diagnostic accuracy and optimize patient care. At the same time, advances in our knowledge about cellular and molecular properties have led to breakthroughs that hold promise for enhancing patient care through new methods of imaging and treating patients beyond the use of radiopharmaceuticals.

The future includes close collaboration among everyone involved in the development of these new technologies: basic scientists conducting multimodality, preclinical imaging research; clinicians conducting clinical trials; a health policy infrastructure addressing regulatory, funding, and outreach activities; and organizations offering educational activities that provide the interdisciplinary education needed to train current scientists and clinicians and develop the future practitioners of molecular imaging and therapy.

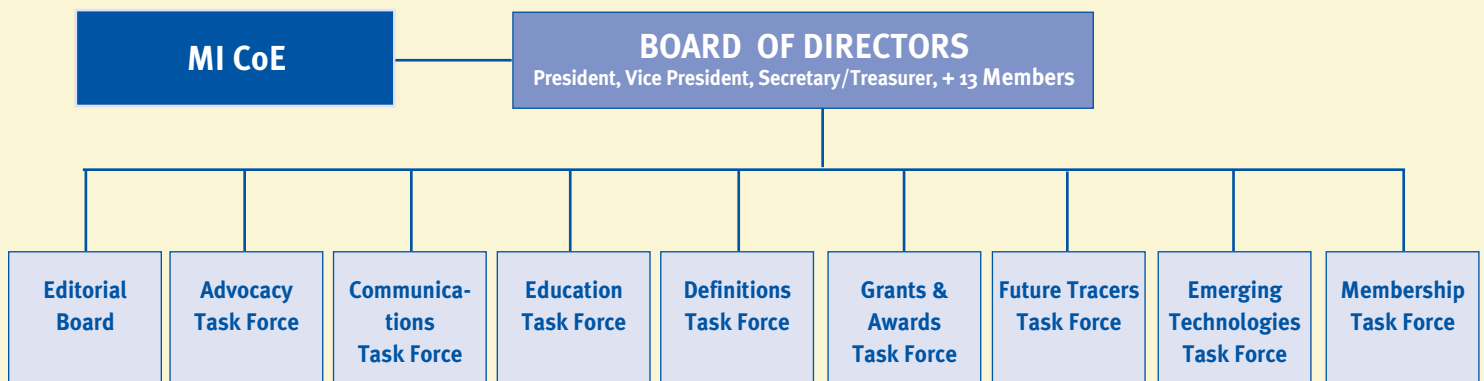
The current MICoE Board of Directors (BOD) includes Henry VanBrocklin, PhD, vice president; Carolyn Anderson, PhD, secretary/treasurer; and BOD members Robert Atcher, PhD; Peter Conti, MD, PhD; John Gore, PhD; Scott Holbrook, CNMT; Craig Levin, PhD; David Mankoff, MD, PhD; Todd Peterson, PhD; Albert Sinusas, MD; George Sgouros, PhD; Michael Stabin, PhD; Mathew Thakur, PhD; Joseph Wu, MD, PhD; and Michael Zalutsky, PhD. Marybeth Howlett is the staff director for the center.

The MICoE BOD has established several task forces to provide leadership for the implementation of key initiatives. A Definitions Task Force, led by Mankoff, has developed a foundation of terminology for molecular imaging and therapy. The

Communications Task Force, under the leadership of Sinusas, is developing a new MICoE Web site and creating materials that discuss the diagnostic and therapeutic benefits of molecular imaging. The Advocacy Task Force, chaired by Atcher, is directing educational sessions for federal agencies and members of Congress that highlight the need for increased research funding and for coordinating an outreach program to develop the awareness of medical, research, patient, and pharmaceutical organizations and build their support for molecular imaging and therapy. The Education Task Force, led by Anderson, is drafting new curricula, educational platforms, and case studies so that nuclear medicine programs can evolve along with molecular imaging and therapy. Thakur chairs the Grants and Awards Task Force, which is recommending new grants and awards to support the development of all types of molecular imaging and therapy from basic research through clinical trials and into clinical practice. The Future Tracers Task Force and the Emerging Technologies Task Force led by VanBrocklin and Sandy McEwan, MD, are coordinating a series of retreats and meetings to identify new molecular imaging agents and instrumentation and methods to apply them. The retreat participants will identify obstacles to these new techniques that may prevent them from becoming clinically viable and will develop plans for overcoming these obstacles. Scott Holbrook is chair of a new Membership Task Force, charged with identifying and recruiting members. Finally, several MICoE members serve as the editorial board, which oversees this newsletter and will determine the topics for monthly contributions to Newsline in *The Journal of Nuclear Medicine*.

We encourage you to become involved in our new, expanded mission. Visit our Web site, join our MI community, become a task force volunteer, or exhibit at the MI Gateway at our annual meeting. We look forward to hearing from you.

Martin G. Pomper, MD, PhD
President, Molecular Imaging Center of Excellence





Report From the Definitions Task Force

Over the past four months, the members of the Molecular Imaging Center of Excellence (MICoE) Definitions Task Force have been developing standard definitions and terms that will serve as the foundation of all communications, advocacy, and education activities for MICoE and SNM. The members of this task force are: David A. Mankoff, MD, PhD (chair); Bennett Chin, MD; William Eckelman, PhD; Jerry Glickson, PhD; Craig Levin, PhD; Chet Mathis, PhD; Barry Shulkin, MD; Albert Sinusas, MD; Michael Stabin, PhD; Mathew Thakur, PhD; Benjamin Tsui, PhD; and Ronald Van Heertum, MD. The group was staffed by Sue Abreu, MD, and Marybeth Howlett, MEM, director of MICoE.

A Definition of Molecular Imaging

The task force recommended, and the MICoE and SNM boards have approved, the following definition of molecular imaging:

- Molecular imaging is the visualization, characterization, and measurement of biological processes at the molecular and cellular levels in humans and other living systems.
- To elaborate, “Molecular imaging typically includes two-or three-dimensional imaging as well as quantification over time. The techniques used include radiotracer imaging/nuclear medicine, MRI, MRS, optical imaging, ultrasound and others.”

The group defined molecular imaging agents as “probes used to visualize, characterize, and measure biological processes in living systems. Both endogenous molecules and exogenous probes can be molecular imaging agents.” Additional standard descriptions developed by the task force include:

- Molecular imaging instrumentation comprises tools that enable visualization and quantification in space and over time of signals from molecular imaging agents.
- Molecular imaging quantification is the determination of regional concentrations of molecular imaging agents and biological parameters. Further, molecular imaging quantification provides measurements of processes at molecular and cellular levels. This quantification is a key element of molecular imaging data and image analysis, especially for inter- and intra-subject comparisons.

To assist with the understanding of molecular imaging in clinical care, statements were developed that can be used to help communicate the importance of molecular imaging:

- Molecular imaging has enormous relevance for patient care: it reveals the clinical biology of the disease process; it personalizes patient care by characterizing specific disease processes in different individuals; and it is useful in drug discovery and development, for example, for studying pharmacokinetics and pharmacodynamics.

- Molecular imaging offers unique insights that allow a more personalized approach to evaluation and management of cardiovascular disease conditions, such as: ischemic injury, heart failure, and left ventricular remodeling; thrombosis, atherosclerosis, and vulnerable plaque; and angiogenesis, transplant rejection, and arrhythmic substrates.
- By accurately characterizing tumor properties or biological processes, molecular imaging plays a pivotal role in guiding cancer patient management: diagnosing, staging (extent and location), assessing therapeutic targets, monitoring therapy, and evaluating prognoses.
- Molecular imaging is a very important diagnostic tool in the early assessment, risk stratification, evaluation, and follow-up of patients with neurological diseases. Molecular imaging is playing an increasingly significant role in neurological conditions such as: tumors, dementias (Alzheimer’s and others), and movement disorders, seizure disorders, and psychiatric disorders.

Molecular imaging is the visualization, characterization, and measurement of biological processes at the molecular and cellular levels in humans and other living systems.

Because these definitions will be used in other communications from the MICoE, formulating these definitions was an important first step for the task force and was done on a relatively brief time scale. The effort and insights of task force members and SNM staff leading to these definitions are greatly appreciated.

*Dave Mankoff, MD, PhD
Chair, Definitions Task Force*

Bench-to-Bedside Molecular Imaging Campaign Off to Great Start

In June 2006, SNM launched the Bench-to-Bedside campaign designed to raise \$5,000,000 over a five-year period for promoting the critical role molecular imaging plays in patient care. GE Healthcare helped jump-start the initiative with a significant pledge, followed by generous support from Bristol-Myers Squibb Medical Imaging, Siemens Medical Solutions USA, Philips, FluoroPharma, IBA Molecular, MDS Nordion, Cardinal Health, and Mallinckrodt, Inc. Total corporate investment now stands at \$3,785,000, and member gifts and pledges, supported by the Education and Research Fund for SNM, have totaled more than \$107,980.

MI Gateway presents a selection of top molecular imaging papers drawn from the wide spectrum of scientific and medical disciplines that are engaging in research in this field. A broader list of published papers is available at www.snm.org/mi. The abstract URL (or PubMed ID number) is included after each title.

HSV-1 viral oncolysis and molecular imaging with PET.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17346109](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt= Citation&list_uids=17346109)

Kuruppu D, Dorfman JD, Tanabe KK. *Curr Cancer Drug Targets*. 2007;7:175–180.

Live dynamic imaging of caveolae pumping targeted antibody rapidly and specifically across endothelium in the lung.

(17334358)

Oh P, Borgstrom P, Witkiewicz H, et al. *Nat Biotechnol*. 2007;25:327–337.

Synthetic affibody molecules: a novel class of affinity ligands for molecular imaging of HER2-expressing malignant tumors.

(17332348)

Orlova A, Tolmachev V, Pehrson R, et al. *Cancer Res*. 2007;67:2178–2186.

MRI detection of transcriptional regulation of gene expression in transgenic mice.

(17351627)

Cohen B, Ziv K, Plaks V, et al. *Nat Med*. 2007;Mar 11.

Reporter proteins for in vivo fluorescence without oxygen.

(17351616)

Drepper T, Eggert T, Circolone F, et al. *Nat Biotechnol*. 2007;Mar 11.

Novel molecular imaging of cell death in experimental cerebral stroke.

(17328873)

Reshef A, Shirvan A, Grimberg H, et al. *Brain Res*. 2007;Feb 1.

MR imaging in assessing cardiovascular interventions and myocardial injury.

(17326039)

Jacquier A, Higgins CB, Saeed M. *Contrast Media Mol Imaging*. 2007;2:1–15.

In vivo imaging of siRNA delivery and silencing in tumors.

(17322898)

Medarova Z, Pham W, Farrar C, et al. *Nat Med*. 2007;13:372–377.

MRI detection of glycogen in vivo by using chemical exchange saturation transfer imaging (glycoCEST).

(17360529)

van Zijl PC, Jones CK, Ren J, et al. *Proc Natl Acad Sci USA*. 2007;104:4359–4364

Fluorine cardiovascular magnetic resonance angiography in vivo at 1.5 T with perfluorocarbon nanoparticle contrast agents.

(17365236)

Neubauer AM, Caruthers SD, Hockett FD, et al. *J Cardiovasc Magn Reson*. 2007;9:565–573.

Radionuclide Therapy of HER2-Positive Microxenografts Using a ¹⁷⁷Lu-Labeled HER2-Specific Affibody Molecule.

(17363599)

Tolmachev V, Orlova A, Pehrson R, et al. *Cancer Res*. 2007;67:2773–2782.

A non-toxic ligand for voxel-based MRI analysis of plaques in AD transgenic mice.

(17291630)

Sigurdsson EM, Wadghiri YZ, Mosconi L, et al. *Neurobiol Aging*. 2007;Feb 7.

Peptide-Based Pharmacomodulation of a Cancer-Targeted Optical Imaging and Photodynamic Therapy Agent.

(17298029)

Stefflova K, Li H, Chen J, et al. *Bioconjug Chem*. 2007;Feb 14.

Specific Targeting of Tumor Angiogenesis by RGD-Conjugated Ultrasmall Superparamagnetic Iron Oxide Particles Using a Clinical 1.5-T Magnetic Resonance Scanner.

(17308094)

Zhang C, Jugold M, Woenne EC, et al. *Cancer Res*. 2007;67:1555–1562.

MI Online

For more MI references with live links to PubMed, go to www.snm.org/mi.

These images are representative of the variety of approaches taken by researchers in the field of molecular imaging. They have been selected to share with readers of MI Gateway as a means of stimulating cross-discipline discussion. The images selected for the first edition of the MICOE newsletter highlight the power of dual modality imaging; but even as we explore the confluence of structure and function, we are moving beyond that to functional/functional imaging with MR/PET. —Henry VanBrocklin, PhD

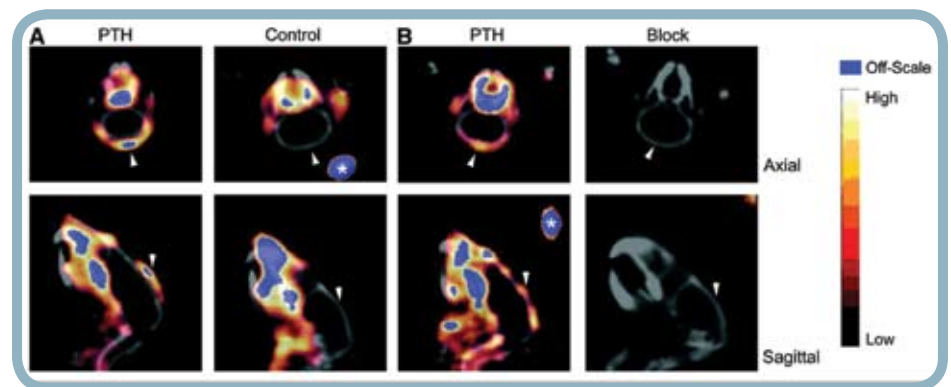
FIG. 1



Multispectral endovascular profiling in normal rat brain. Endovascular brain mapping is a promising imaging and surgical guidance technique that aims to identify functional regions of the brain prior to resection of injured or diseased tissue. In preclinical modeling, we have employed multiparametric profiling of the endovascular space via simultaneous molecular imaging of two different optical probes, each targeting unique brain vascular phases. Fluorescence emission profiles of the two probes were spectrally unmixed to visualize the vascular targeting of each molecular imaging agent. Image false colored, probe A = red, probe B = green.

Image provided by H. Charles Manning, PhD, Vanderbilt University Nashville, TN

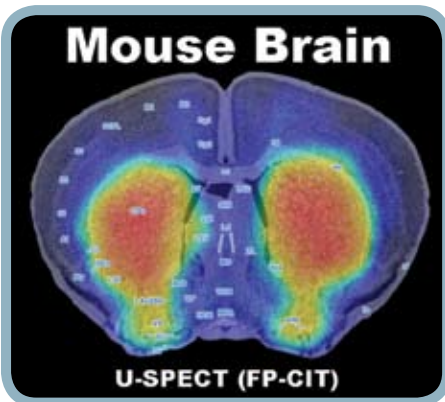
FIG. 2



Coregistered microPET and microCT images (MAP reconstructed). microPET/CT images of mice treated with either parathyroid hormone (PTH) or vehicle, demonstrating that ^{64}Cu -CB-TE2A-c(RGDyK) is taken up by increased numbers of osteoclasts in a model of PTH-induced osteolysis. These studies demonstrate that ^{64}Cu -CB-TE2A-c(RGDyK) may have applications as an imaging agent for bone diseases that are characterized by increased numbers of osteoclasts, such as osteolytic bone metastases, rheumatoid arthritis or osteoporosis.

Image provided by Carolyn Anderson, PhD, Washington University Medical School, St. Louis, MO. Reprinted with permission from *The Journal of Nuclear Medicine* (2007;48:316).

FIG. 3



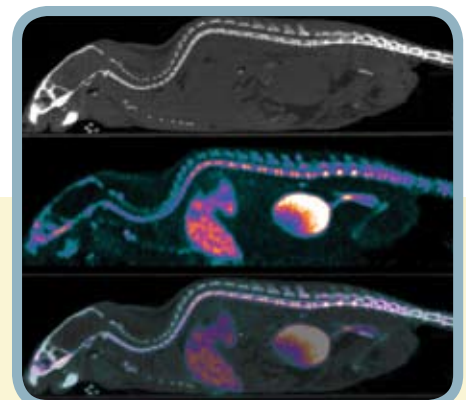
FP-CIT image acquired with U-SPECT with anatomic overlay allowing quantification of dopamine dynamics in sub-compartments of the living mouse brain for the first time.

Image provided by Freek J. Beekman, PhD, University Medical Centre, Utrecht, The Netherlands

In vivo whole-body mouse images acquired by U-SPECT/CT with a resolution of approximately 0.5 mm. Top, CT; middle, U-SPECT, bottom, fused.

Image provided by Freek J. Beekman, PhD, University Medical Centre, Utrecht, The Netherlands

FIG. 4



MI Gateway will continue to showcase images of small-animal, cellular, and human molecular imaging in each issue. Please consider sharing images from your research with MICOE members via this newsletter. Published images should be submitted with permission to reprint from your publisher. Unpublished images can be freely submitted and will remain your property. Please provide citation and caption—you may include commentary or context in the caption—not to exceed 100 words. Send high resolution images to MolecularImaging@snm.org.



MI Gateway presents a sampling of research and news of interest to the community of molecular imaging scientists. Click the headlines to read the full story if reading online, or access these articles at www.snm.org/mi.

New Imaging Approach Promises Insights Into Multiple Sclerosis

Researchers have developed a way to use three types of microscopic imaging techniques simultaneously to analyze living tissue and learn more about the molecular mechanisms of multiple sclerosis, information that could help lead to earlier detection and new treatments.

AACR, FDA and NCI Announce Cancer Biomarkers Collaborative

The American Association for Cancer Research, together with the FDA and NCI, announces the formation of the AACR-FDA-NCI Cancer Biomarkers Collaborative to facilitate the use of validated biomarkers in clinical trials and ultimately in evidence-based oncology and cancer medicine.

Breast Cancer Diagnosis From Combined MRI-Optics Method

By combining magnetic resonance imaging (MRI) and near-infrared optics, researchers at Dartmouth College and Dartmouth Medical School may have devised a new, potentially more accurate method for diagnosing breast cancer.

Structural Basis for Photoswitching in Fluorescent Proteins Brought Into Focus

University of Oregon scientists have identified molecular features that determine the light-emitting ability of green fluorescent proteins, and by strategically inserting a single oxygen atom they were able to keep the lights turned off for up to 65 hours.

MRI Uses Fluorine-Laced Nanoparticles to Track Cells

Nanoparticles could soon allow researchers and physicians to directly track cells used in medical treatments using unique signatures from the ingested nanoparticle beacons.

New Molecular Imaging Compound Pinpoints Cancer Spread in Mice

Researchers have created a new imaging compound in mice that selectively binds to certain cancer cells and glows, or fluoresces, only when processed by these cells.



MI Online

Read the full text of these articles and find recent MI news at www.snm.org/mi.

A Closer Look Inside Our Lungs—Penn Researchers Develop Two Novel Imaging Techniques

Researchers at the University of Pennsylvania School of Medicine (Philadelphia) are harnessing two new, non-invasive techniques to look more closely inside the working lungs—leading to early detection of diseases like emphysema before they become evident in other modes of imaging.

Researchers Wake Up Viruses Inside Tumors to Image and Then Destroy Cancers

Researchers have found a way to activate Epstein-Barr viruses inside tumors as a way to identify patients whose infection can then be manipulated to destroy their tumors. They say this strategy could offer a novel way of treating many cancers associated with Epstein-Barr, including at least four different types of lymphoma and nasopharyngeal and gastric cancers.

Natural Antibiotics Yield Secrets to Solid State NMR Spectroscopy

Frog skin and human lungs hold secrets to developing new antibiotics, and a technique called solid-state NMR spectroscopy is a key to unlocking those secrets.

Stable, Non-toxic Form of Gold Nanoparticles Developed; May Be Useful in Molecular Imaging and Therapy

New research at the University of Missouri–Columbia has found that a plant extract can be used to create a new type of gold nanoparticle that is stable and nontoxic and can be administered orally or injected.

How T Lymphocytes Attack

At the Institut Curie researchers have used two-photon microscopy to demonstrate, for the first time in vivo and real time, how T lymphocytes infiltrate a solid tumor in order to fight it.

Fluorescent Biomarker Tracks Metabolic Activity in Neurons

A protein that causes coral to glow is helping researchers study brain cells that are critical for the proper functioning of the central nervous system. This fluorescent marker protein may shed light on brain cell defects believed to play a role in various neurological diseases.

IMAGING TECHNIQUE	EM RADIATION SPECTRUM USED IN IMAGE GENERATION	ADVANTAGES	DISADVANTAGES
Positron emission tomography (PET)	High energy gamma rays	High sensitivity; isotopes can substitute for naturally occurring atoms; quantitative; translational research	PET cyclotron or generator needed; relatively low spatial resolution; radiation of subject
Single photon emission computed tomography (SPECT)	Lower energy gamma rays	Many molecular probes available; can image multiple probes simultaneously; may be adapted to clinical imaging systems	Relatively low spatial resolution; radiation
Optical bioluminescence imaging	Visible light	Highest sensitivity; quick, easy, low cost, and relatively high throughput	Low spatial resolution; currently 2-D imaging only; relatively surface-weighted; limited translational research
Optical fluorescence imaging	Visible light or near-infrared	High sensitivity; detects fluorochrome in live and dead cells	Relatively low spatial resolution; relatively surface-weighted
Magnetic resonance imaging (MRI)	Radio waves	Highest spatial resolution; combines morphologic and functional imaging	Relatively low sensitivity; long scan and postprocessing time; mass quantity of probe may be needed
Computed tomography (CT)	X-rays	Bone and tumor imaging; anatomic imaging	Limited 'molecular' applications; limited soft tissue resolution; radiation
Ultrasound	High-frequency sound	Real time; low cost	Limited spatial resolution; mostly morphologic although targeted microbubbles under development

The founding principles of molecular imaging can be traced back to nuclear medicine procedures over the past few decades, with other technologies (e.g., optical, MRI) being adapted for molecular imaging by developing different types of molecular probes. At the widest level, there exist two classes of probes: nonspecific and specific. Nuclear medicine plays a key role in the latter class, as the signaling portion of specifically targeted probes. Probes that use antibodies, ligands, or substrates to specifically interact with protein targets in particular cells or subcellular compartments include those used in most of the conventional radiotracer imaging methods, where the emphasis is on imaging final products of gene expression with radiolabeled substrates that interact with a protein originating from a specific gene. These interactions are based on either receptor-radioligand binding (e.g., binding of ^{11}C -carfentanil to the mu opiate receptor) or enzyme mediated trapping of a radiolabeled substrate (e.g., ^{18}F -2-fluoro-2-deoxyglucose [^{18}F -FDG] phosphorylation by hexokinase).

However, the main limitation of most of these specific approaches is that a new substrate must be discovered and radiolabeled to yield a different probe for each new protein target. With the significant difficulty, cost, and effort involved in radiolabeling new substrates, along with the requirement for in vivo characterization of every such substrate under investigation, more generalizable methods (i.e., those that can image gene product targets arising from the expression of any gene of interest) are preferred. This issue has propelled the development and validation of molecular imaging reporter gene/reporter probe systems in recent years for use in living subjects together with other generalizable strategies.

Other Molecular Imaging Strategies

The various existing imaging technologies differ in five main aspects: (1) spatial resolution; (2) depth penetration; (3) energy expended for image generation (ionizing or nonionizing, depending on which component of the electromagnetic radiation spectrum is exploited for image generation); (4) availability of injectable/biocompatible molecular probes; and (5) the respective detection threshold of probes for a given technology. See table.

Given that certain imaging techniques have advantages and disadvantages over others, it becomes important to have available a

variety of imaging strategies to accomplish the increasingly sophisticated biologic interrogation of cells that molecular imaging now offers.

For example, the use of MRI has two particular advantages over techniques involving radionuclides or optical probes: higher spatial resolution (micrometers as opposed to several millimeters) and the ability to extract physiologic and anatomic information simultaneously. Although MRI has a much lower sensitivity, if there are enough targets (e.g., vascular endothelial proteins), then MRI may be the best-suited tool. On the optical side, the main advantage of bioluminescence imaging lies in its ability to detect very low levels of gene expression due to its virtually background-free light emission. In addition, its quick and easy implementation facilitates rapid testing of biologic hypotheses and proofs-of-principle in living experimental models, not to mention its unique suitability for high-throughput imaging due to its ease of operation, short acquisition times (usually 10 to 60 seconds), and the capability for simultaneous measurement of several anesthetized living mice.

Future Fusion

As molecular imaging continues to advance, we should see radionuclide-based approaches, with PET/SPECT remaining an integral part of the molecular imaging toolbox. This will likely be the case because PET and SPECT are the most generalizable of all the available molecular imaging strategies, allowing interrogation of events at any tissue depth and allowing targeting of extracellular proteins, cell surface proteins, intracellular proteins, and others (e.g., mRNA). Although nuclear medicine could ignore the growth of the larger field of molecular imaging, a likely better strategy is to be more inclusive of other technologies that can also help interrogate processes at the cellular/molecular level. In addition, a fusion of different molecular imaging strategies as well as a fusion of anatomical and molecular imaging will likely be key to improved patient management. Although it is difficult to predict the future, it is likely that molecular imaging will continue to grow. We need to continue to educate ourselves and be a part of that growth. ●

Sam Gambhir, professor of radiology and bioengineering, is director of the molecular imaging program and head of nuclear medicine at Stanford University in Stanford, CA.



Key Meetings of Interest to the Molecular Imaging Community – 2007

SNM Annual Meeting

June 2–6, Washington, DC
www.snm.org/am

43rd ASCO Annual Meeting

June 1–5, McCormick Place Chicago, IL
www.asco.org/portal/site/ASCO/am

ESMI Second International Conference

June 14–15, Naples, Italy
www.esminapoli.org/

Frontiers of Biomedical Imaging Science

June 27–29, Nashville, TN
www.vuhs.vanderbilt.edu/frontiers/index.php

American Chemical Society: 234th Meeting

August 19–23, Boston, MA
www.chemistry.org/meetings

ASNC 12th Annual Scientific Session

September 6–9, San Diego, CA
www.asnc.org/symposium06

ASTRO Translation Research in Radiation Oncology, Physics & Biology

September 7–9, San Francisco, CA
<http://astro.org/Meetings>

AMI/RSNA/SNM/SMI Clinical Pre-conference Symposium: Imaging in Molecular Medicine

September 7–8, Providence, RI
www.molecularimaging.org/2007jointconf/preconference.php

AMI/SMI Molecular Imaging Joint Conference

September 8–11, Providence, RI
www.molecularimaging.org/2007jointconf/home07.php

Imaging 2020: Theragnostic Imaging

September 23–27, Jackson Hole, WY
www.imagingin2020.com/

ACRIN Semi-Annual Meeting

September 27–30, Pentagon City, Arlington VA
www.acrin.org/meetings.html

EANM 2007

October 13–17, Copenhagen, Denmark
<http://eanm07.eanm.org>

ASTRO 49TH Annual Meeting

Oct. 28–Nov. 1, Los Angeles, CA
www.astro.org/meetings

2007 IEEE Nuclear Science Symposium and Medical Imaging Conference

Oct. 28–Nov. 3, Honolulu, HI
www.nss-mic.org/2007/NSS07Poster.pdf

Taipei International Symposium on Molecular Imaging

October 30–31, National Yang-Ming University, Taipei, Taiwan, ROC
www.molecularimaging.org/pdf/taipei_mi_poster.pdf

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